EXOMETOECA NYCTERIS MEYRICK (LEPIDOPTERA: HESPERIIDAE: PYRGINAE): LIFE HISTORY AND MORPHOLOGICAL STUDIES

ANDREW F. ATKINS[1], ANDREW A.E. WILLIAMS[2] and MATTHEW R. WILLIAMS[3]

[1] *Faculty of Architecture, University of Newcastle, Callaghan, NSW 2308*

[2] *Department of Conservation and Land Management, W.A. Wildlife Research Centre, PO Box 51, Wanneroo, WA 6065*

[3] *Department of Conservation and Land Management, Science and Information Division, 50 Hayman Road, Como, WA 6152*

Abstract

The life history of the Western Australian endemic skipper *Exometoeca nycteris* Meyrick is described and illustrated. Juvenile and adult morphology, distribution and behavior indicate that this uncommon, cryptic species is a geographic and taxonomic isolate. The larval food plants are *Tetratheca hispidissima* and *T. hirsuta* (Tremandraceae), both of which are restricted to southwestern Western Australia. The monotypic genus *Exometoeca* Meyrick is compared to allied genera of the Australian subfamily Pyrginae.

Introduction

The Western Flat *Exometoeca nycteris* Meyrick, 1888 is an Australian endemic, monotypic skipper belonging to the subfamily Pyrginae ('Flats'). It is known only from the southwestern corner of Western Australia and ranges from Chittering to Margaret River and Albany (Braby 2000). This distribution is unique for genera of Australian Hesperiidae and *E. nycteris* is the only species of the subfamily to occur in southwestern Australia. Few localities are recorded for this small skipper and the life history has eluded lepidopterists for over a hundred years.

In the Perth area adults are most commonly seen in October. Further south near Albany the peak flying time is late November and early December. In early December 1999 we searched localities near Albany where the butterfly was known to occur. A population was found at Bakers Junction Nature Reserve (34°54'S 117°56'E) enabling us to closely study the habits, biology and food plant of this species. These observations were subsequently compared with a northern site at Lesmurdie near Perth, where larvae were found on a similar food plant.

Life history

Food plants. Tremandraceae: *Tetratheca hispidissima* Steetz from Bakers Junction Nature Reserve near Albany and *Tetratheca hirsuta* Lindley from Lesmurdie near Perth.

Egg (Figs 3-4, 26-27). Diameter 0.8 mm; dome shaped, 18-21 prominent vertical ribs, broken and inter-connecting near micropyle. Very faint cross-ribbing is present between the vertical ribs, the surface punctured with scattered pores. The micropyle (Fig. 27) is a simple circular and expanding

series of quadrant pores. The egg is pale yellow when first laid but darkens to orange-yellow within a day or two (Figs 3-4). Prior to hatching the micropyle darkens, the black larval head showing through the chorion.

First instar larva (Figs 5-6). Length 2-4 mm. Head large and rounded with a slight dorsal groove, shiny black and covered with numerous pale clubbed or simple setae. Body yellow at first but turning slightly greenish after a few days, covered with short cup-shaped or clubbed setae (Fig. 11), the anal segments with longer simple setae.

Second instar larva. Length 4-6 mm. Similar to above, but body green with an indistinct darker mid-dorsal line, posterior segment yellowish. Head slightly produced dorsally and sclerotized, brown with a pair of lighter brown stripes dorsally and either side of frons. Both head and body are covered with short cup-shaped and clubbed setae. At first the second instar larva appears to have an extended or raised prothoracic plate, but this disappears after a few days.

Third instar larva (Figs 7-8). Length 6-8 mm. Body green with indistinct darker mid-dorsal line, similar to second instar, but head capsule with two pronounced dorsal horns. Head colour very variable, some entirely dark brown, others more predominantly pale greenish with dark brown or red-brown markings.

Fourth instar larva (Fig. 10). Length 8-12 mm. Similar to third instar, body green and sparsely covered with short, clubbed setae. The head capsule is also covered with clubbed setae. It is predominantly green with variable red-brown markings.

Final instar larva (Fig. 12). Length 17-19 mm. Similar to fourth instar but with head green, usually with prominent red markings extending midway either side of frons and upwards to well pronounced dorsal horns.

Pupa (Figs 13,16). Length 15 mm. Stout and rounded, bright green, covered with mottled pale grey waxy exudation. Head (operculum) (Fig. 9) with blunt brown central projection. Thoracic spiracle, bright reddish brown, round and prominent. Wing-case distally speckled with black along venation lines. Proboscis case (Fig. 25) dorsally projecting beyond wing case to a brown swollen tip. Abdominal segments sparsely covered with short, simple, pale setae; spiracles dark brown. Cremaster brown, moderately long, decurved, laterally convex; tip with short pale hooks. Mid-section of pupa supported by Y-shaped strong silken girdle (partly shown in Fig. 13).

Adult (Figs 1, 2, 17). Male and female similar, reddish brown above with hyaline spots in the median area of the forewing, underside light greyish brown with dark brown to purplish brown markings in distal area, hyaline spots as above, male slightly smaller, forewing length 15 mm; wing venation (Fig.18) with forewing cell medium and blunt, M_2 slightly nearer M_1 than M_3

at point of origin, CuA_2 nearer to base than to CuA_1, humeral vein present near base, male with narrow costal fold from base to Rs_2, hindwing with M_2 well defined, discocellulars equal, concave and parallel to margin; labial palpus (Fig. 19) brown above, cream beneath with second segment moderately broad, oval, elliptical, laterally depressed, slightly twisted, third segment long, narrow, and directed forward (porrect); antenna (Figs 1-2) moderate with shaft 40-45 segments, club (Fig. 20) 21 segments tapered evenly, thickening 1/3rd its length, bent 2/3rd its length, nudum 14, reddish brown: legs (Fig. 21) mid brown, pale brown beneath, moderately long, with one pair of spurs on mid tibia, two pairs of spurs on hind tibia (0:1:2), fore tibia with long, slightly curved apophysis.

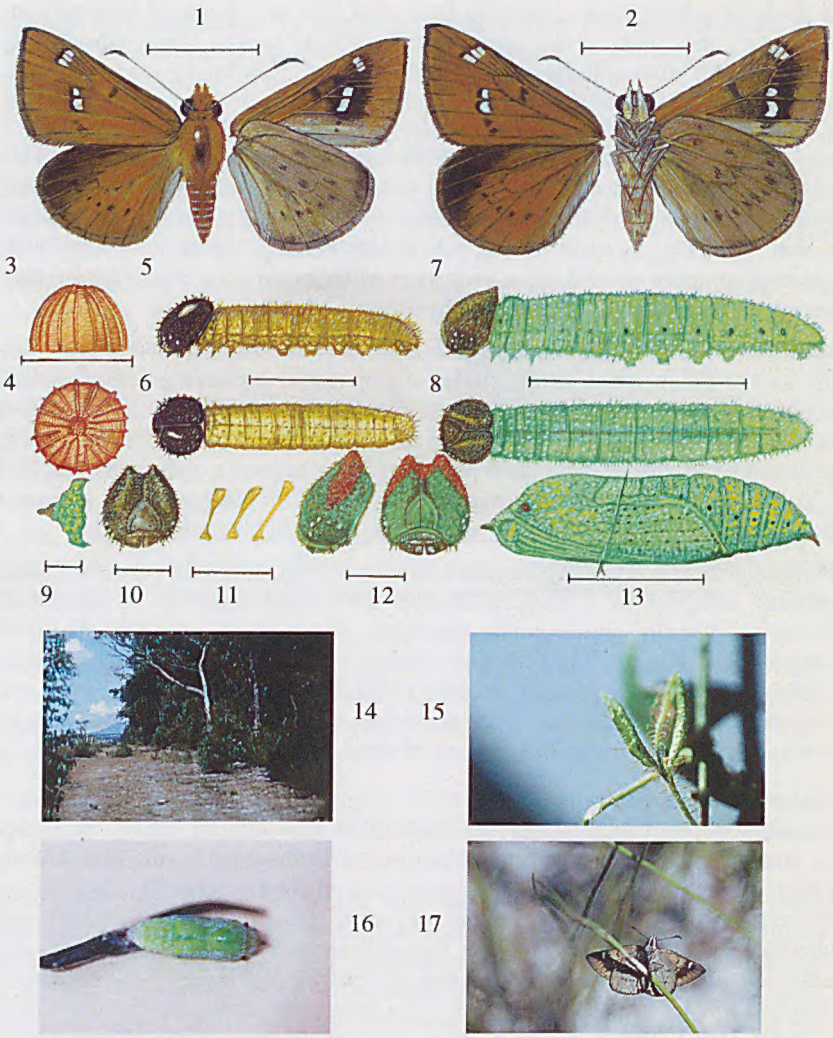
Male genitalia (Fig. 22). Aedeagus moderate with simple rounded posterior tip, valvae symmetrical, simple, divided with dorsal segment greatly reduced, ventral segment curved upward, slightly sclerotized and with blunt, toothed tip, saccus long, two-thirds length of valvae, juxta simple ring-shaped, tegumen hood-shaped with deep paired gnathos, tegumen and uncus junction with paired, broadly curved, crescent shaped lateral flange, uncus a simple dorsally pointed, decurved spatulate process, slightly hooked ventrally.

Female genitalia (Fig. 23). Papilla anellus a simple, rounded, concave paired process attached to a crescent-shaped sclerotized segment 9, apophysis moderate, lamella antevaginalis (sterigma plate) prominent, broadly dish-shaped with slightly bifid, lipped ventral surface, ostium bursae (caudal chamber) narrow ring-shaped, slightly tilted dorsally, ductus bursae long and narrow, coiled to spherical corpus bursae (bursa copulatrix) with paired, ventrally placed, spiracle-like signum covered with short spines.

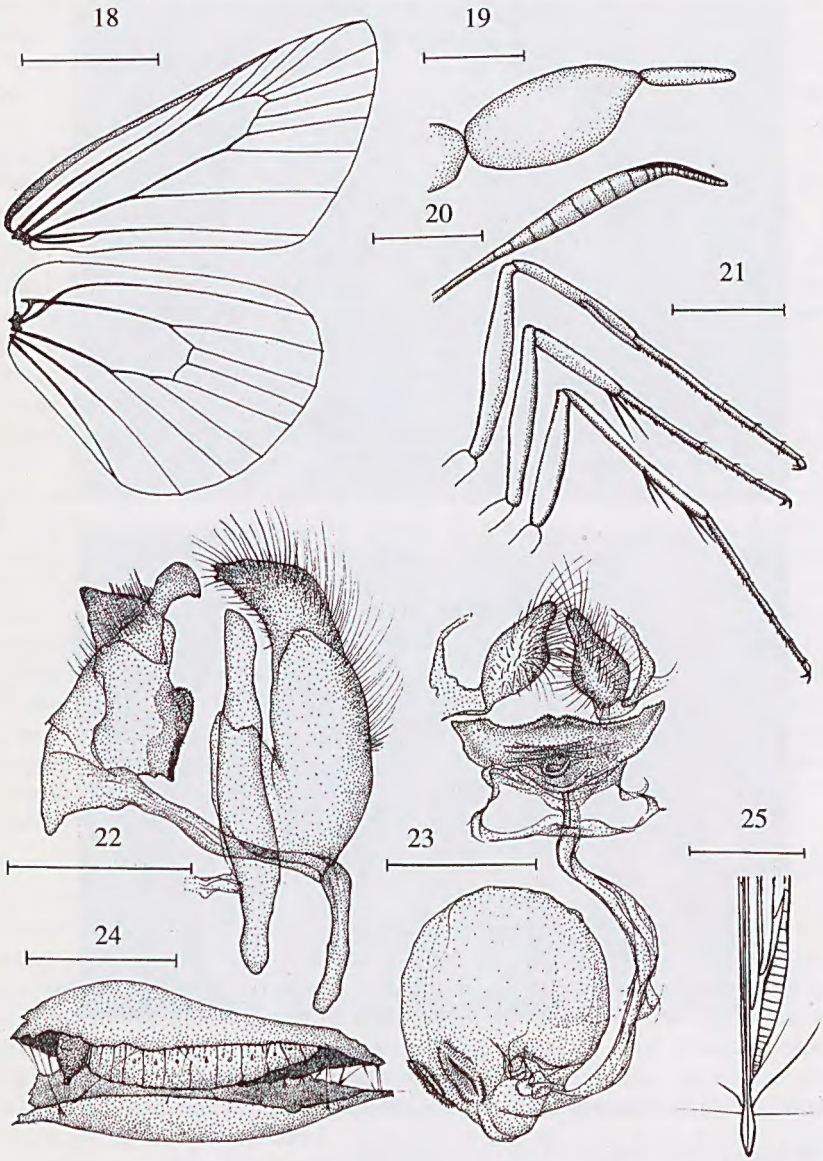
Location and habitat

Bakers Junction Nature Reserve is located 13 km north of Albany. It covers an area of 1090 ha in a gently undulating upland dissected by shallow valleys. Much of the surrounding land has been cleared for farming. The bulk of the reserve supports a low woodland of jarrah (*Eucalyptus marginata*) and sheoak (*Allocasuarina fraseriana*). Dense *Homalospermum firmum* heath and associated low woodland complexes of *Eucalyptus marginata*, *E. staeri*, *Banksia attenuata* and *Agonis parviceps* are found along the drainage lines (Griffin 1985). The *E. nycteris* site is in jarrah/sheoak low woodland, within which are small open areas of winter-wet heathland. These heathland areas support low flowering shrubs, including *Pimelea* sp. and *Dasypogon bromeliifolius* and a strong component of other monocotyledons.

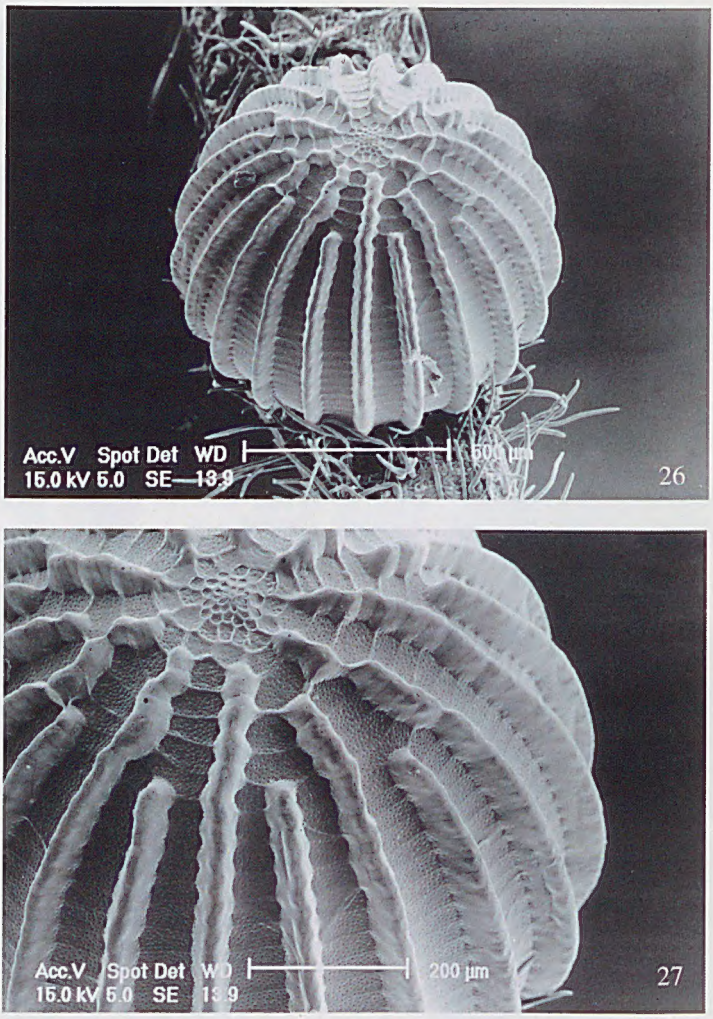
The northern site at Lesmurdie is on the west-facing upper slopes of the Darling Scarp, overlooking Perth. It is an open woodland of Marri (*Eucalyptus calophylla*) and Wandoo (*Eucalyptus wandoo*), forming the transition zone between jarrah forest and adjacent areas of low heathland on gravel and rocky soil.



Figs 1-17. Biology and habitat of *Exometoeca nycteris*. (1) male upper and underside; (2) female upper and underside; (3) lateral view of egg; (4) dorsal view of egg; (5) lateral view of 1st instar larva; (6) dorsal view of 1st instar larva; (7) lateral view of 3rd instar larva; (8) dorsal view of 3rd instar larva; (9) operculum of pupa; (10) frons of 4th instar larva; (11) larval setae; (12) lateral view and frons of final instar larva; (13) lateral view of pupa; (14) flight and breeding area at Bakers Junction Nature Reserve; (15) egg laid on leaf axil of *Tetratheca hispidissima*; (16) ventral view of pupa; (17) basking adult male in 'signalling' posture. Scale lines: Figs 1-2 = 10 mm; figs 3-6 = 1 mm; figs 7, 8, 13 = 5 mm; figs 9, 10, 12 = 2 mm; fig. 11 = 0.5 mm.



Figs 18-25. Morphology and biology of *Exometoeca nycteris*. (18) wing venation of male; (19) labial palpus; (20) antennal club; (21) fore, mid and hind tibia of male; (22) lateral view of male genitalia (everted upwards); (23) ventral view of female genitalia; (24) leaf-litter shelter of 4th instar larva; (25) pupal proboscis case. Scale lines: Figs 18, 24 = 5 mm; figs 19, 22, 23 = 1 mm; figs 20, 21, 25 = 2 mm.



Figs 26-27. Micrographs of *Exometoeca nycteris* egg.

Life history and behavioural observations

Initial observations were made at Bakers Junction Nature Reserve (Fig. 14) on 1 December 1999. Males were observed flying slowly, at the edge of and within damp areas of woodland. They appeared to be seeking freshly emerged females and on one occasion four males were seen hovering within a metre of each other, investigating a shaded area of dense thicket.

Nearby, in sunny areas, females were observed on flowering herbs. One female was seen to fly directly and swiftly from a flower, across an open area of heathland, to a shaded, damp area of the surrounding woodland. Here, after quick inspection, it oviposited near the tip of a *Tetratheca hispidissima* plant (Fig. 15) growing amongst other understorey species. The female then moved away rapidly. Careful examination of other *T. hispidissima* plants in the vicinity produced more eggs, all of which were laid on the young tips of the food plant, most frequently in the axil between the stem and uppermost leaf.

Eggs collected at Bakers Junction Nature Reserve were then transferred to potted *T. hispidissima* plants (at Wanneroo) for observation. Young larvae were also placed on potted *T. thymifolia* (an eastern Australian species) and held at Dudley, NSW. The eggs hatched within 12-13 days and the first instar larvae initially ate most of the egg-shell, then subsequently fed on the growing tips or youngest leaves of the food plant. Most larvae constructed flimsy dome-shaped shelters on the underside of a leaf, pulling the edges of the leaf closer together with strands of silk. Other larvae rested in the axil between stem and uppermost leaf (where the egg was laid), wrapping strands of silk around both for protection. The young larvae remained in their shelters, feeding occasionally on either their leaf-shelter or nearby leaves. Periodically new shelters were constructed as the old ones were eaten away. The larvae rested upside-down and were extremely cryptic. The green body colour matched the foliage perfectly, while the dark markings on the head capsules matched discoloured patches on the leaves. As larvae increased in size they sometimes moved from their leafy shelters on the food plant to construct new more substantial shelters on the ground (Fig. 24). These shelters were constructed from leaf litter and bark near the base of the food plant. Periodically larvae would leave their shelters to feed and then, within 15-20 minutes, return to their shelters.

Visits were made to Lesmurdie and Bakers Junction Nature Reserve during the year to monitor the progress of larval development in the wild. At Lesmurdie larvae fed sporadically in October and November when fresh young leaves of the food plant *T. hirsuta* were available. However, in the hot dry summer months the plants clasped their leaves close to the stems, probably to minimise water loss. During this time there was no sign of larval activity. Larvae only resumed feeding again when the food plants became more turgid in response to autumn rain. Larvae were mature by August and were found in shelters formed from a number of leaves of the food plant, or incorporating fallen dead leaves. They pupated in their shelters in late August and early September. Adults emerged after 20 days.

At Bakers Junction Nature Reserve and at Dudley, NSW the situation was rather different. In these areas larvae fed intermittently throughout the summer, reaching third instar by March. The milder southern and south-eastern conditions no doubt enabled the *Tetratheca* food plants to maintain

fresh growth on which the young larvae could feed more readily. One captive larva pupated at the end of October and emerged approximately 21 days later.

Little has been published on the habits of adult *E. nycteris*. Common and Waterhouse (1981) stated that the species flies for about an hour in the morning before 1000 h and then again for a similar period after midday (an observation attributed to A.N. Burns). However, Barrett and Burns (1951) state that 'It does not appear until about nine or later in the morning, it increases until after midday when it gradually disappears and by four in the afternoon not a specimen is to be seen'. At Bakers Junction Nature Reserve, adult *E. nycteris* were active during sunny spells throughout the day between 0900 and 1500 h. Both males and females congregated in small open areas of winter-wet heathland, where they visited the flowers of *Pimelea* sp. and *Dasypogon bromeliifolius*. Males also established 'territories' in these open areas, often perching on prominent dead sticks or taller sedges (Fig. 17). At other times they were seen spiralling together high above the ground.

The usual feeding posture of *E. nycteris* is typical of pyrginid skippers, with wings outstretched horizontally or occasionally upright over the thorax, or even bent slightly downward around the flower head. The wing tips of this species (as in many skippers of this subfamily) are slightly depressed. However, when resting or basking both sexes generally revert upside-down, wings spread flat, under curving monocotyledon leaves. This posture is assumed either head upwards or head downwards and exposes the strongly marked apical area of the underside of the wing either side of the leaf-blade (Fig. 17). We believe that this may be an intraspecific signalling pattern, which is in contrast to the cryptic upperside of the wings that is exposed when feeding.

Predators and parasites

One predator of adult *E. nycteris* was observed at Bakers Junction Nature Reserve, this being an unidentified species of a reddish-coloured crane fly (Tipulidae) that was carrying a freshly emerged but dead adult female across a clearing. A few small parasitic wasps (*Eriborus* sp. [Ichneumonidae: Campopleginae]) also emerged in captivity from fourth instar larvae of *E. nycteris*. The wasp is probably undescribed. This is the first record of a skipper as host for *Eriborus* Foerster, which usually parasitises pyralid moth larvae (I. D. Gauld, pers. comm.).

Discussion

Exometoeca nycteris is a geographically isolated taxon known only from southwestern Western Australia. The male has a costal fold (Fig. 18) not previously recorded for this monotypic genus, but other secondary sexual structures (i.e. tibial and anal hair-tufts, wing-sterigma) are absent. The skipper shows no unusual structural features, apart from the horned larval head, the long third segment of the labial palpus and long saccus and curved

uncus flange of the male genitalia, but these are not unique in Pyrginae. A well-defined hindwing vein M_2 is also found in several less specialised pyrginid skippers, such as some species of the *Erynnis* Schrank group of genera from Europe and North and South America and the unique Australian *Euschemon* Doubleday. Tibial spur configuration of *E. nycteris* (0:2:4) is shared by all Australian pyrginid genera (note that this is contrary to Evans' 1949 diagnosis). The structure of the female genitalia indicates that *E. nycteris* may be distantly related to the Australian *Netrocoryne* C. & R. Felder, the Madagascan and African *Eagris* Guenée or the pan-tropical *Celaenorrhinus* Hübner. However in these genera the first instar larvae make distinctive, elaborate circular or rectangular shelters cut from the leaf of the food plant and have differing features of adult and juvenile morphology. The generally unspecialised adult and juvenile morphology suggests that *E. nycteris* is a somewhat 'primitive' skipper and it appears to have no close relatives.

The family Tremandraceae, endemic to southern Australia, was previously unrecorded as a larval food plant for Hesperiidae. It comprises about 47 species distributed in 3 genera. *Tetratheca* forms the bulk of these (see Thompson 1976), with 24 species in Western Australia alone. The two known larval food plants, *T. hirsuta* and *T. hispidissima*, are multi-stemmed shrubs that grow to about 1 m high. The former species grows in laterite, grey sand and granite soils and is found generally from about Geraldton to near Albany; the latter species is found on sand, lateritic sand and loam and is restricted to the far southwest of Western Australia (Keighery 1979). The family Tremandraceae is placed in the Order Rutales with apparent close affinities to Polygalaceae, but also with affinities to Malpighiaceae (Malpighiales) (Bhattacharyya and Johri 1998). Genera and species of Malpighiaceae are recorded as larval food plants of several pyrginid and coeliadinid skippers, especially in tropical countries.

Further searches for colonies of this skipper are needed to establish its conservation status. *E. nycteris* appears to have a very short flying period. Only one brood has been recorded from late spring (northern range: Perth area) to early summer (southern range: Albany area). Very few colonies are known, but this may be an artifact of a short flying season, localised occurrence or specialised habitat. Although local, the larval food plants are fairly broadly distributed in southwestern Western Australia and *E. nycteris* may be more widespread and locally common than previously thought.

Dried *Tetratheca* material held in the Western Australian Herbarium collections was examined for signs of ova of *E. nycteris*. One hatched eggshell was found on a *T. hirsuta* specimen collected near Beraking (32°10'S 116°24'E), southeast of Sawyer's Valley, suggesting the presence of *E. nycteris* at this locality.

Voucher specimens pertinent to this paper are lodged in the Insect Collection of the Western Australian Department of Conservation and Land Management and in Andrew Atkins' private collection. Food plant specimens have been lodged in the Western Australian Herbarium, Perth. Plant nomenclature follows Green (1985).

Acknowledgements

We thank Greg Keighery, Department of Conservation and Land Management, Perth for the identification of host plants and botanical information. Ted Edwards (CSIRO, Canberra) kindly provided location sites. We thank Gary Weber (University of Newcastle) for the micrographs and Ian D. Gauld (The Natural History Museum, London) for the identification of the wasp parasite. The current listings of WA *Tetratheca* was accessed from the WA Herbarium Florabase. Andrew Atkins would like to thank the WA Department of Conservation and Land Management for logistic support; the committees for OSPRO and Research (in particular Lyn McBriarty); the University of Newcastle, NSW for study leave and travel funding; and Barry Maitland and Alan Morse (Faculty of Architecture, University of Newcastle) for the opportunity for study leave as part of this research.

References

BARRETT, C. and BURNS, A,N. 1951. *Butterflies of Australia and New Guinea.* Griffin, Netley S.A; 187 pp.

BHATTACHARYYA, B. and JOHRI, B.M. 1998. *Flowering plants: taxonomy and phylogeny.* Springger-Verlag, New York; 753 pp.

BRABY, M.F. 2000. *The butterflies of Australia: their identification, biology and distribution.* CSIRO Publishing, Melbourne; 976 pp.

COMMON, I.F.B. and WATERHOUSE, D.F. 1981. *Butterflies of Australia.*. Angus and Robertson, Sydney; xiv + 682 pp.

EVANS, W.H., 1949. *A catalogue of the Hesperiidae from Europe, Asia and Australia in the British Museum (Natural History).* British Museum (Natural History). London; 502 pp, 53 pls.

GREEN, J.W. 1985. *Census of the vascular plants of Western Australia.* Western Australian Herbarium, Department of Agriculture, Perth; 312 pp.

GRIFFIN, E.A. 1985. *Vegetation survey of Bakers Junction and Millbrook nature reserves (Shire of Albany).* Department of Conservation and Land Management, Western Australia; unpublished report.

KEIGHERY, G.J., 1979. *Notes on the biology and phytogeography of Western Australian plants, Part 5: Tremandraceae.* Kings Park Botanic Garden, West Perth; unpublished report.

THOMPSON, J. 1976. A revision of the genus *Tetratheca* (Tremandraceae). *Telopea* **1**(3): 139-215.